(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 717 582 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.11.2001 Bulletin 2001/46

(51) Int Cl.[7]: **H05B 6/68**

(21) Application number: **95105499.8**

(22) Date of filing: **12.04.1995**

(54) **Heating time control apparatus and method thereof for a microwave oven**

Heizzeit-Kontrollvorrichtung und Verwendung dieser in einem Mikrowellenofen

Appareil de contrôle du temps de chauffage et son application à un four à microondes

(84) Designated Contracting States:
DE FR GB SE

(30) Priority: **16.12.1994 KR 3462294**

(43) Date of publication of application:
19.06.1996 Bulletin 1996/25

(73) Proprietor: **LG ELECTRONICS INC.**
Seoul (KR)

(72) Inventors:
- **Chai, Eun Sik**
  Kyungsangnam-Do (KR)
- **Lee, Kwan Ho**
  Kyungsangnam-Do (KR)

(74) Representative: **Cohausz & Florack**
Patentanwälte
Kanzlerstrasse 8a
40472 Düsseldorf (DE)

(56) References cited:
EP-A- 0 001 396
EP-A- 0 023 971
EP-A- 0 024 798
EP-A- 0 239 290
EP-A- 0 587 323
US-A- 5 155 339

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 717 582 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a heating time control apparatus and a method thereof for a microwave oven, and particularly to an improved heating time control apparatus and method thereof for a microwave oven capable of advantageously computing an optimum cooking time without controlling food amount to be cooked or a predetermined initial cooking time by detecting varying rate of gas of the food thereby computing a cooking time in accordance with the detected varying rate of gas.

2. Description of the Conventional Art

[0002] Conventionally, in heating food using a microwave oven, an optimum heating time of food is determined by various factors such as an initial temperature and amount of food to be cooked, desired heating temperature and power of a microwave oven. One such method of determining an optimum heating time is disclosed in USP RE 31,094, which detects an optimum food state using rapidly varying moisture levels of food being cooked and a second heating time in accordance with the detected food state using a predetermined algorithm. However, in cases where moisture sharply increases as when cooking frozen food or where the moisture varying rate is low due to a particular characteristic during heating, there may be a big difference between a computed heating time and an actual heating time. In addition, in the case of warming food, the time during which the moisture amount increases sharply exceeds the time at which the level reaches 100°C which is larger than the warming temperature of 60° to 85°. Therefore, there is a big difference in heating time because the entire heating time is computed based upon a time when rapid changes of moisture occurs.

[0003] Accordingly, in an attempt to resolve such problems, USPTO 4,336,433 discloses a method, which is directed to differing a predetermined constant K of determining a food heating time in accordance with the kind and amount of food to be cooked in determining a second heating time. However, even though the constant K is computed in accordance with the kind and amount of food, since the initial state of food is not considered there are still discrepancies between the computed heating time and the actually required heating time when frozen food is cooked and a food warming function is used. In addition, in determining the constant K, it takes much time because it comes from an experimental basis.

[0004] Furthermore, in an attempt to solve the above problems, USP 4,335,293 discloses an approach intended to set a time of increasing a predetermined time at a minimum of moisture variance as a first heating time and to set a second time in accordance with the set first heating time. However, the above retention has largely retained the same problems as in the prior.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to provide a heating time control apparatus and a method thereof for a microwave oven, which overcomes the problems encountered in the conventional heating time control apparatus and a method thereof for a microwave oven.

[0006] It is another object of the present invention to provide an improved heating time control apparatus and a method thereof for a microwave oven capable of advantageously computing an optimum cooking time without controlling food amount or a predetermined initial cooking time by detecting varying rate of gas of the food thereby computing a cooking time in accordance with the detected varying rate of gas.

[0007] To achieve one object thereof, there is provided with a heating time control apparatus, comprising sensor means for repeatedly detecting a predetermined parameter of a food as the food is being heated and for outputting an initial parameter value of said predetermined parameter and for converting variations of the parameter into a predetermined electrical signal; converting means for comparing the parameter to the initial value and for converting the parameter into a varying ratio based on the initial value; heating time detecting means for setting a first heating time based on the varying ratio reaching a minimum value and for setting a second heating time based on the varying ratio varying from the minimum value to a predetermined value; storing means for storing the minimum value outputted from said heating time detecting means, said first heating time and said second heating time; coefficient storing means for storing a predetermined coefficient in accordance with kinds of food to be cooked; operating means for outputting a quotient obtained by dividing the first heating time by a first coefficient from said coefficient storing means in order for the second heating time to be determined in said heating time detection means, and for calculating a third heating time by multiplying a sum of the first and the second heating times by a second coefficient outputted from said coefficient storing means; a counter for producing microwave drive signals based on a counting of the first and second heating times outputted from the heating time detecting means and the third heating time outputted from said operating means; and output drive means for controlling a supply of a microwave energy to the food in accordance with the drive signals of said counter.

[0008] To achieve another object thereof, there is provided with a heating time control method, comprising the steps of converting a physical parameter of a food while the food is being heated into a varying ratio based on

an initial value of said parameter and counting first heating time until the converted varying ratio becomes a minimum value; computing a predetermined divided value by dividing the first heating time by a first coefficient in accordance with the kind of food being cooked and counting a second heating time until said varying ratio increases from the minimum value by said divided value; calculating a third heating time by multiplying a second food kind coefficient by the sum of said first heating time and said second heating time; and ending the entire heating process when said calculated third heating time has elapsed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is a block diagram showing a construction of a microwave oven according to the present invention.

[0010] Fig. 2 is a graph showing a computation procedure of heating time according to the present invention.

[0011] Fig. 3 is a graph showing a method of computing a first heating time when there is no a duration that a varying rate of food gas is reduced according to the present invention.

[0012] Fig. 4 is a graph showing a method of computing heating time in accordance with an amount and an initial state of food according to the present invention.

[0013] Fig. 5 is a graph showing a characteristic when various parameters obtained while food is cooked are converted into a varying ratio for an initial state value of cooking.

[0014] Fig. 6 is a flow chart showing a heating time control method of a microwave oven according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to Fig. 1, a heating time control apparatus of a microwave oven according to the present invention is provided with a heating compartment 2 for heating food 1. An air intake opening 3 is formed on a predetermined portion of the heating compartment 2 for intaking outside air into the heating compartment 2. An air exhausting opening 4 is formed on a predetermined portion of the heating compartment 2 for forcibly exhausting air containing food gas occurred while cooking food therein. A sensor 5 is mounted on a predetermined portion close to the air exhausting opening 4 for detecting gas exhausting from the air exhausting opening 4 and for converting the detected gas into a predetermined electric signal. In addition, the present invention is provided with a converter 6 for computing a varying ratio Rs/Ro for an initial value using an initial value Ro outputted from the sensor 5 and a varying value Rs obtained over time, a detector 7 for detecting a value dG1 which becomes a minimum value of a varying rate of gas outputted from the converter 6 and determining a preheating time Tp which is the lapsed time of detecting the value dG1 and for selecting a first heating time T1 by comparing the preheating time Tp and a predetermined time Tmin set at the minimum value setting section T1 described below and for determining a second heating time T2 by computing time lapsed for increasing a predetermined value dG outputted from the operator described below, a storing circuit 8 for storing a minimum value of a gas varying ratio outputted from the detector 7 and for the first and second heating time T1 and T2, a coefficient storing circuit 9 for storing experimentally determined coefficients a and K in accordance with a kinds of food, an operator 10 for operating a value of a gas varying ratio so as to determine a second heating time T2 using a mininium value dG1 of a gas varying ratio outputted from the storing circuit 8, a first heating time T1 and a coefficient 'a' outputted from the coefficient storing circuit 9 and for operating a third heating time T3 using a first, second heating times T1 and T2 outputted from the storing circuit 8 and a coefficient K outputted from the coefficient storing circuit 9, a counter 11 for counting a first and second heating times T1 and T2 outputted from the heating time detector 7 and a third heating time T3 outputted from the operator 10, an output drive circuit 12 for controlling a magnetron 13 in accordance with a output signal of the counter 11, and a magnetron 13 for transferring a microwave to the heating compartment 2 in accordance with a control of the output drive circuit 12.

[0016] In addition, the heating time control apparatus is further provided with a minimum time setting circuit 14 for outputting a predetermined time Tmin for being a first heating time T1 when a minimum value dG1 of a gas varying ratio Rs/Ro is not detected from the heating time detector 7, and a heating time controller 15 for properly controlling the computed third heating time T3 when a user selects a heating level of the food 1 such as well down and rare.

[0017] The operation of a heating time control apparatus of a microwave oven will now be explained.

[0018] When a cooking operation begins after a menu and heating level are selected by a user, the food in the heating compartment 2 is heated by microwaves outputted from the magnetron 13. At this time, gas and moisture coming from the food 1 is exhausted through the air exhausting opening 4. Thereafter, the sensor 5 detects the exhausting gas and moisture and converts the detected state into a predetermined electric signal and outputs the signal to the converter 6. As shown in Fig. 2, the converter 6 computes an initial value Ro outputted from the sensor 5 and a varying value Rs varying in accordance with a lapsing time, and computes a varying gas ratio Rs/Ro. The heating time detector 7 detects a value dG1 which is a minimum value of the varying ratios of the gas and sets a preheating time Tp required for the detection.

[0019] Here, the varying ratio of the gas starts increasing as the heating operation proceeds while at the

initial stage of the cooking operation it decreases due to the effects of the air sucked through the air intake opening 3. After the heating proceeds and the food is properly heated, the gas varying ratio Rs/Ro no longer increases due to the saturation of gas in the heating compartment 2. In addition, in case of the same food, the preheating time Tp that the varying ratio of the gas is a minimum value dG1 become longer unless the amount of food is big, and the initial temperature is low, and the power of the microwave is low.

[0020] Thereafter, the heating time detector 7 outputs the minimum value dG1 to the storing circuit 8 and compares the preheating time Tp with the minimum time Tmin set in the minimum time setting circuit 14. As a result of the comparison, if Tp ≥ Tmin, the heating time detector 7 selects Tp as the first heating time T1 and outputs it to the storing circuit 8 and the counter 11, respectively. Meanwhile, if Tp ≤ Tmin, the heating time detector 7 selects Tmin as the first heating time T1 and outputs it to the storing circuit 8 and the counter 13. If Tmin is set as the first heating time T1, the value of the gas varying ratio at the point Tmin is selected and stored in the storing circuit 8. The counter 11 counts the first heating time T1 outputted from the heating time detector 7 and outputs the counted time to the output drive circuit 12. In addition, the output drive circuit 12 drives the magnetron 13 in accordance with a output signal of the counter 13, and the magnetron 13 supplies the heating compartment 2 with microwaves generated in accordance with a control of the output drive circuit 12.

[0021] The reasons why the preheating time Tp and the minimum time Tmin is selectively selected as the first heating time T1 is for the short duration even though the varying ratio of gas increases or decreases while cooking food due to the characteristics of food or the heating condition. Because, in case that the varying ratio of gas is not decreased, since the preheating time is close to zero, the second and third heating times T2 and T3 which are determined by the first heating time T1 are not correctly computed. That is, in the case that the varying ratio of gas is not decreased or the duration is short even though it is decreased, the first heating operation is performed with a predetermined time Tmin set in the minimum time setting circuit 14, so that the second and third heating times T2 and T3 can correctly be computed.

[0022] Fig. 2 shows a varying ratio of gas when foods 'a' and 'b' weighing 113 grams (4 ounce) and 227 grams (8 ounce) respectively, and that the relationship between the preheating time Tp and the minimum time Tmin is Tp ≥ Tmin. As shown therein the first heating time T1 is set as T1a and T1b, respectively. Fig. 3 shows the case where Tmin is selected as the first heating time T1 when Tp<Tmin that is when the varying gas ratio came from the food 1 is not decreased.

[0023] Meanwhile, the storing circuit 8 stores the output signals dG1 and T1 of the heating time detector 7. In addition, the operator 10 performs an operation of computing the second heating time T2 using a coefficient 'a' stored in the coefficient storing circuit 9, the coefficients all being selected on an experimental basis in accordance of the kind of food to be cooked. The operator 10 computes the value dG by dividing the first heating time T1 by the coefficient 'a,' and obtains the value dG2 by adding the value dG to the value dG1 outputted from the storing circuit 8. The condition is as follows.

$$dG = T1/a$$

$$dG2 = dG1+dG = dG1+T1/a$$

[0024] Wherein the second heating time T2 is determined as a lapsed time while the value dG1 becomes dG2 at a point after the first heating is completed. Therefore, if the value dG2 obtained from the operator 10 is outputted to the heating time detector 7, the heating time detector 7 detects lapsed time while the varying ratio dG1 of gas becomes the dG2 increased by dG and sets the detected lapsed time as the second heating time T2 and outputs it to the storing circuit 8 and the counter 11 . Thereafter, the counter 11 counts the second heating time T2 and outputs the counted second heating time T2 to the output drive circuit 12. In addition, the output drive circuit 12 controls the oscillation of the magnetron 13 in accordance with an output signal of the counter 11.

[0025] Fig. 2 shows a lapsed time T2a and T2b each indicating a lapsed time while a varying ratio of gas from a food 'a' becomes a dG2a increased by dGa and a lapsed time while a varying ratio of gas from a food 'b' becomes a dG2b increased by dG. In addition, Fig. 3 shows the case where the second heating time T2 is determined in case that there is no decrease of a varying ratio.

[0026] The operator 10 computes the third heating time T3 using a first and second heating times T1 and T2 which are stored in the storing circuit 8 and a coefficient K stored in the coefficient storing circuit 9 determined in accordance with the kinds of food. The third heating time T3 is obtained by multiplying a result obtained by adding the first heating time T1 and the second heating time T2 by the coefficient K. That is, it is obtained by the condition below.

$$T3 = (T1 + T2) \times K$$

[0027] The operator 10 computed the third heating time T3 outputs the computed result to the counter 11. The counter 11 counts the second heating time T2 and the third heating time T3 outputted from the operator 10 and outputs it to the output drive circuit 12. The output drive circuit 12 controls the oscillation of the magnetron in accordance with a predetermined output signal of the counter 11. Thereafter, the magnetron 13 generates mi-

crowaves to the heating compartment 2 for the third heating time T3 in accordance with a drive of the output driving circuit 12 and then the heating operation is completed.

[0028] The addition of the first, second and third heating times T1, T2 and T3 becomes the total heating time Tt. That is, the condition is given as follows.

$$Tt = T1 + T2 + T3 = T1 + T2 + K \times (T1 + T2)$$

[0029] Meanwhile, in case that a user wants to heat the food more or less, the user can control the cooking condition by controlling a heating time control section 15. When the user controls the heating time control section 15 in such a way, the heating time control section 15 outputs a predetermined coefficient β obtained in accordance with a heating level selected by the user to the operator 10 just after the third heating time T3 is computed. The operator 10 multiplies the computed total heating time Tt by the coefficient β and then adds or subtracts the multiplied result δT to or from the total heating time Tt. Therefore, the operator 10 outputs the third heating time T3' to the counter 11 in accordance with a predetermined heating level selected by a user. The relationship between the total heating time tt' and the third heating time T3' is given as follows.

$$Tt' = Tt \pm \delta T$$

$$= Tt \pm \beta \times (T1 + T2 + T3)$$

$$T3' = T3 \pm \beta \times (Tt)$$

[0030] In addition, there are some occasions that a varying ratio of gas is low even though the weight of the food to be cooked is substantial. Fig. 4 shows that the foods c, d and e each weigh 4 ounces, 8 ounces and 12 ounces respectively, and each Tp thereof is greater than Tmin.

[0031] As shown in Fig. 4, even though the food e weighs more than the food d, the time T1e that the varying ratio of gas reaches a minimum is shorter than T1d of the food d. In this case, since the second heating time T2 is determined by a "dG2 = dG1 + dG = dG1 + T1/a, the second heating time T2d for the food d is the time T2d while the varying ratio of gas increases by up to dGd = T1d/a. The second heating time T2e for the food e is the time T2e while the varying ratio of gas increase by up to dGe T1e/a as well.

[0032] However, since the amount of the food e is greater than the food d, the slope of the varying ratio of gas of the food e is more slightly increased than that of the food d. Therefore, even though the variation amount dGe of the varying ratio of gas of the food e is less than that of the food d, the time T2e while the varying ratio of gas of the food e increase by up to dGe is longer than that of T2d. That is, whereas the first heating time T1 is determined by the initial characteristics of the food, after the second heating time T2, it is determined by characteristics of the graph showing a varying ratio of gas of food obtained in accordance with the amount of food. Therefore, the total heating time Tt is determined by the amount of the food to be cooked irrespective to the first heating time T1. Referring to Fig. 4, the first heating time T1c of the food c has the same time as in the first heating time T1e. However, since the amount of the food c is less than that of the food e, the total heating time Ttc is shorter than that of the food e.

[0033] Meanwhile, there are various methods so as to detect the heating level of food. Among the methods, detecting gas, temperature in the heating compartment, or infrared rays from the surface of the food is common. If the parameter to be detected is temperature, the varying ratio of temperature (°C) is used. If the absolute moisture (gm/cm^3), the varying ratio of moisture per unit is used. If the relative moisture (%), the varying ratio of the moisture against room temperature. If the infrared ray (cm), the varying ratio of infrared ray wave in accordance with the temperature variation is used. Any one of these can be used to compute the heating time of food as having a characteristics similar to the one shown in Fig. 5.

[0034] Referring to Fig. 6, the procedure of setting the heating time of food will now be explained below.

[0035] After placing a food in the heating compartment 2, a user selects a heating level in accordance with the kind of food to be cooked. Thereafter, the counter 11 counts time in accordance with a mode selected by the user and outputs the counted time to the output drive circuit 12. The output drive circuit 12 controls the oscillation of the magnetron 13 in accordance with a predetermined signal of the counter 11. Thereafter, the magnetron 13 supplies the heating compartment 2 with microwaves, whereby the food in the heating compartment 2 is cooked.

[0036] When the food is cooked, gas is exhausted to the outside through the air exhausting opening 4. At this time, the sensor 5 close to the air exhausting opening 4 detects the gas being exhausted and converts the detected state into a predetermined electric signal and outputs the signal to the converter 6. The converter 6 computes the varying ratio Rs/Ro of gas using the initial value Ro outputted from the sensor 5 and the varying value Rs obtained as time passes and outputs the computed results to the detector 7.

[0037] The heating time detector 7 detects a minimum value dG1 as the varying ratio of gas decreases and then increases and outputs the detected value to the storing circuit 8. In addition, the heating time detector 7 detects the preheating time Tp until the minimum value dG1 is detected and compares the preheating time Tp with the minimum time Tmin set in the minimum time setting circuit 14. As a result of the comparison, if Tp ≥

Tmin, the heating time detector 7 selects the Tp as the first heating time T1 and outputs the selected time to the storing circuit 8 and the counter 11. If Tp ≤ Tmin, the heating time detector 7 selects the Tmin as the first heating time T1 and outputs the selected time to the storing circuit 8 and the counter 11.

[0038] Thereafter, the storing circuit 8 outputs the minimum value dG1 and the first heating time T1 to the operator 10, and the coefficient storing circuit 9 outputs the coefficient e in accordance with the kind of food to the operator. In addition, the operator 10 operates the variation (dG = T1/a) of the varying ratio of gas so as to determine the second heating time T2 and adds the minimum value dG1 of the varying ratio of gas to the operated value dG and outputs the added value (dG2 = dG1 + dG) to the detector 7.

[0039] The heating time detector 7 detects the time T2 that the varying ratio of gas reaches from the dG1 to the value dG2 outputted from the operator and outputs the detected time T2 to the storing circuit 8 and the counter 11. The operator 10 computes the third heating time T3 for the second heating time T2 using the first and second heating times T1 and T2 and the coefficient K stored in the coefficient storing circuit 9. Here, the third heating time T3 is computed as a T3 = K(T1 +T2) outputted to the counter

[0040] The operator 10 judges whether or not a control of the heating level is inputted by checking the heating time control circuit 15 before outputting the third heating time T3. If there is no inputted heating level control, the operator 10 outputs the operated third heating time T3 to the counter 11. However, if there is a predetermined inputted heating level control, the operator 10 operates the heating time controlled by the user and outputs the result to the counter 11. Therefore, the counter 13 counts the third heating time T3' controlled by the controlled total heating time Tt' and outputs the counted result to the output drive circuit 12. Thereafter, the output drive circuit 12 drives the magnetron 13 for as much as the time t3' and then the cooking operation is terminated.

[0041] As described above, the heating time control apparatus and the method thereof according to the present invention is directed to computing the second and third heating time by computing a varying ratio of gas in the first heating period, whereby a wide range of foods can be cooked under optimum conditions without controlling the amount of food and without regard to the initial temperature conditions such as the frozen state, refrigeration state, and room temperature state of food. In addition, the present invention is intended to prevent the food from being overheated when warming or reheating the food by using the first heating time when there is no minimum point in the curve indicating the varying ratio of gas or there is no minimum value, so that the optimum cooking condition is attained.

Claims

1. A heating time control apparatus, comprising:

sensor means (5) for repeatedly detecting a predetermined parameter (R_s) of a food as the food is being heated and for outputting an initial parameter value (R_o) of said predetermined parameter (R_s) and for converting variations of the parameter (R_s) into a predetermined electrical signal;

converting means (6) for comparing the parameter (Rs) to the initial value (Ro) and for converting the parameter (R_s) into a varying ratio (Rs/Ro) based on the initial value (Ro);

heating time detecting means (7) for setting a first heating time (T1) based on the varying ratio (Rs/Ro) reaching a minimum value (dG1) and for setting a second heating time (T2) based on the varying ratio (Rs/Ro) varying from the minimum value (dG1) to a predetermined value (dG2);

storing means (8) for storing the minimum value (dG1) outputted from said heating time detecting means (7), said first heating time (T1) and said second heating time (T2);

coefficient storing means (9) for storing a predetermined coefficient (a) in accordance with kinds of food to be cooked;

operating means (10) for outputting a quotient (dG) obtained by dividing the first heating time (T1) by a first coefficient (a) from said coefficient storing means (9) in order for the second heating time (T2) to be determined in said heating time detection means (7), and for calculating a third heating time (T3) by multiplying a sum of the first heating time (T1) and the second heating time (T2) by a second coefficient (K) outputted from said coefficient storing means (9);

a counter. (11) for producing microwave drive signals based on a counting of the first heating time (T1) and second heating time (T2) outputted from the heating time detecting means (7) and the third heating time (T3) outputted from said operating means (10); and

output drive means (12) for controlling a supply of a microwave energy to the food in accordance with the drive signals of said counter (11).

2. The apparatus of claim 1, wherein said sensor means (5) is effective for measuring a predetermined parameter variation selected from the parameter group of gas, temperature, absolute moisture, relative moisture, infrared rays and combinations thereof.

3. The apparatus of claim 1, wherein said heating time

detecting means (7) selects a predetermined set time (Tmin) as the first heating time (T1) in the event when the minimum value (dG1) of the varying ratio is not reached and outputs a value of the varying ratio (Rs/Ro) at the selected time (Tmin) as the first heating time (T1).

4. The apparatus of claim 1, wherein said second heating time (T2) represents time during which the varying ratio (Rs/Ro) varies by a predetermined value (dG) from the completion of the first heating time (T1).

5. The apparatus of claim 1, wherein said operating means (10) includes a heating level selected by a user and said operating means (10) produces said third heating time (T3) controlled in accordance with the heating level by multiplying a total heating time (Tt) by a predetermined coefficient (β) determined by the heating level and by adding or subtracting the multiplied value (δT) to or from the third heating time (T3) .

6. The apparatus of claim 1, wherein said predetermined value (dG) is obtained by dividing said first heating time (T1) by a first coefficient (a).

7. A heating time control method, comprising the steps of:

converting a physical parameter (R_s) of a food while the food is being heated into a varying ratio (Rs/Ro) based on an initial value (Ro) of said parameter and counting a first heating time (T1) until the converted varying ratio (Rs/Ro) becomes a minimum value (dG1);
computing a predetermined divided value (dG) by dividing the first heating time (T1) by a first coefficient (a) in accordance with the kind of food being cooked and counting a second heating time (T2) until said varying ratio (Rs/Ro) increases from the minimum value (dG1) by said divided value (dG);
calculating a third heating time (T3) by multiplying a second food kind coefficient (K) by the sum of said first heating time (T1) and said second heating time (T2); and
ending the entire heating process when said calculated third heating time (T3) has elapsed.

8. The method of claim 7, wherein said step of setting said first heating time (T1) includes selecting a predetermined set time (Tmin) as said first heating time (T1) when said varying ratio (Rs/Ro) increases and outputs the value of varying ratio (Rs/Ro) in the selected time (Tmin) as the minimum value (dG1).

9. The method of claim 7, including obtaining said third heating time (T3) in accordance with a predetermined heating level by adding or subtracting the value (δT) obtained by multiplying a computed total heating time (dT) by a predetermined coefficient (β) to and from the third heating time (T3) just after the third heating time (T3) is operated in case that a user controls a heating level.

Patentansprüche

1. Heizzeit-Kontrollvorrichtung, umfassend:

Sensormittel (5) zur wiederholten Erfassung eines vorbestimmten Parameters (Rs) einer Speise, während des Erhitzens der Speise und zum Abgeben eines Anfangs-Parameterwertes (Ro) des genannten vorbestimmten Parameters (Rs) und zum Umwandeln der Änderungen des Parameters (Rs) in ein vorbestimmtes elektrisches Signal;

Umwandlungsmittel (6) zum Vergleichen des Parameters (Rs) mit dem Anfangswert (Ro) und zum Umwandeln des Parameters (Rs) in ein Änderungsverhältnis (Rs/Ro), das auf dem Anfangswert (Ro) basiert;

Heizzeit-Erfassungs-Mittel (7) zum Setzen einer ersten Heizzeit (T1), die auf dem Änderungsverhältnis (Rs/Ro) basiert und einen Minimumwert (dG1) erreicht, und zum Setzen einer zweiten Heizzeit (T2), die auf dem Änderungsverhältnis (Rs/Ro) basiert, welches sich vom Minimumwert (dG1) auf einen vorbestimmten Wert (dG2) verändert;

Speichermittel (8) zum Speichern des Minimumwertes (dG1), der von dem erwähnten Heizzeit-Erfassungs-Mittel (7) ausgegeben wird, der erwähnten ersten Heizzeit (T1) und der erwähnten zweiten Heizzeit (T2);

Koeffizienten-Speichermittel (9) zum Speichern eines vorbestimmten Koeffizienten (a) in Übereinstimmung mit der Art der zu kochenden Speise;

Prozessormittel (10) zum Ausgeben eines Quotienten (dG), der durch Dividieren der ersten Heizzeit (T1) durch einen ersten Koeffizienten (a) aus dem Koeffizienten-Speichermittel (9)erhalten wird, um eine zweite Heizzeit (T2) zu erhalten, die in dem Heizzeit-Erfassungs-Mittel (7) bestimmt wird, und zum Errechnen einer dritten Heizzeit (T3) durch Multiplizieren einer Summe aus der ersten Heizzeit (T1) und der zweiten Heizzeit (T2) mit einem zweiten Ko-

effizienten (K), der vom Koeffizienten-Speichermittel (9) ausgegeben wird;

einen Zähler (11) zum Erzeugen eines Mikrowellen-Treibersignals, basierend auf der Erfassung der ersten Heizzeit (T1) und der zweiten Heizzeit (T2), die vom Heizzeit-Erfassungs-Mittel (7) und der dritten Heizzeit (T3), die vom Prozessormittel (10) ausgegeben wird; und

Ausgangs-Treibermittel (12) zur Steuerung der Lieferung einer Mikrowellen-Energie zu der Speise in Übereinstimmung mit dem Treibersignal des erwähnten Zählers (11).

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** die Sensormittel (5) einsetzbar sind zur Messung einer Änderung eines vorbestimmten Parameters, der aus der Gruppe von Parametern ausgewählt ist, die die Gastemperatur, absolute Feuchtigkeit, relative Feuchtigkeit, Infrarot-Strahlen und Kombinationen von diesen umfaßt.

3. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** das Heizzeit-Erfassungs-Mittel (7) eine vorbestimmte Setz-Zeit (Tmin) als die erste Heizzeit (T1) in dem Fall auswählt, daß der Minimumwert (dG1) des Änderungsverhältnisses (Rs/Ro) nicht erreicht wird, und einen Wert des Änderungsverhältnisses (Rs/Ro) zu der gewählten Zeit (Tmin) als die erste Heizzeit (T1) ausgibt.

4. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** die zweite Heizzeit (T2) eine Zeit darstellt, während der sich das Änderungsverhältnis (Rs/Ro) um einen vorbestimmten Betrag (dG) nach dem Ablauf der ersten Heizzeit (T1) ändert.

5. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** das Prozessormittel (10) einen Heizpegel einschließt, der vom Benutzer ausgewählt wird, wobei das Prozessormittel (10) die dritte Heizzeit (T3) erzeugt, gesteuert in Übereinstimmung mit dem Heizpegel durch Multiplizieren einer Gesamt-Heizzeit (Tt) mit einem vorbestimmten Koeffizienten (β), der bestimmt ist durch den Heizpegel und durch Addieren oder Substrahieren des multiplizierten Wertes (δT) zu oder von der dritten Heizzeit (T3).

6. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** der vorbestimmte Wert (dG) durch Dividieren der ersten Heizzeit (T1) durch einen ersten Koeffizienten (a) erhalten wird.

7. Verfahren zur Steuerung einer Heizzeit, umfassend die folgenden Schritte:

Umwandlung eines physikalischen Parameters (Rs) einer Speise, während die Speise erwärmt wird, in ein Änderungsverhältnis (Rs/Ro) basierend auf einem Anfangswert (Ro) dieses Parameters und Erfassen einer ersten Heizzeit (T1), bis das umgewandelte Änderungsverhältnis (Rs/Ro) einen Minimumwert (dG1) erreicht;

Berechnung eines vorbestimmten dividierten Wertes (dG) durch Dividieren der ersten Heizzeit (T1) durch einen ersten Koeffizienten (a) in Übereinstimmung mit der Art der zu kochenden Speise und Erfassen einer zweiten Heizzeit (T2), bis sich das Änderungsverhältnis (Rs/Ro) um den dividierten Wert (dG) erhöht gegenüber dem Minimumwert (dG1);

Berechnung einer dritten Heizzeit (T3) durch Multiplizieren eines zweiten der Art der Speise entsprechenden Koeffizienten (K) mit der Summe aus der ersten Heizzeit (T1) und der zweiten Heizzeit (T2) ;

und Beenden des gesamten Heizprozesses, wenn diese berechnete dritte Heizzeit (T3) verstrichen ist.

8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet, daß** der Schritt des Setzens der ersten Heizzeit (T1) das Auswählen einer vorbestimmten Setz-Zeit (Tmin) als erste Heizzeit (T1) einschließt, wenn sich das Änderungsverhältnis (Rs/Ro) erhöht und den Wert des Änderungsverhältnisses (Rs/Ro) in der gewählten Zeit (Tmin) als den Minmumwert (dG1) ausgibt.

9. Verfahren nach Anspruch 7, einschließend das Erhalten der in Übereinstimmung mit einem vorbestimmten Heizpegel stehenden dritten Heizzeit (T3) durch Addieren oder Subtrahieren des Wertes (δT), welcher durch Multiplizieren einer berechneten gesamten Heizzeit (dT) mit einem vorbestimmten Koeffizienten (β) erhalten wird, zu oder von der dritten Heizzeit (T3), nachdem die dritte Heizzeit (T3) in dem Fall gesetzt wurde, daß der Benutzer einen Heizpegel überwacht.

Revendications

1. Appareil de contrôle du temps de chauffage, comprenant :

des moyens formant capteur (5) servant à détecter de façon répétée un paramètre prédéterminé Rs concernant un aliment alors que l'aliment est chauffé et, à produire une valeur de paramétrage initiale (Ro) pour ledit paramètre

prédéterminé (Rs) et à convertir les variations du paramètre (Rs) en un signal électrique prédéterminé ;
des moyens de conversion (6) servant à comparer le paramètre (Rs) à la valeur initiale (Ro) et à convertir le paramètre (Rs) en un ratio variable (Rs/Ro) en se basant sur la valeur initiale (Ro) ;
des moyens de détection du temps de chauffage (7) servant à déterminer un premier temps de chauffage (T1) en se basant sur le ratio variable (Rs/Ro) atteignant une valeur minimale (dG1) et à déterminer un second temps de chauffage (T2) en se basant sur le ratio variable (Rs/Ro) passant de la valeur minimale (dG1) à une valeur prédéterminée (dG2) ;
des moyens de mémorisation (8) servant à mettre en mémoire la valeur minimale (dG1) produite par lesdits moyens de détection du temps de chauffage (7), ledit premier temps de chauffage (T1) et ledit second temps de chauffage (T2) ;
des moyens de mémorisation des coefficients (9) servant à mettre en mémoire un coefficient prédéterminé (a) en fonction de la nature des aliments à chauffer ;
des moyens opérationnels (10) servant à produire un quotient (dG) obtenu par la division du premier temps de chauffage (T1) par le premier coefficient (a) provenant desdits moyens de mémorisation des coefficients (9) de façon à déterminer le second temps de chauffage (T2) dans lesdits moyens de détection du temps de chauffage (7) et à calculer un troisième temps de chauffage (T3) en multipliant la somme du premier temps de chauffage (T1) et du second temps de chauffage (T2) par un second coefficient (K) produit par lesdits moyens de mémorisation des coefficients (9) ;
un compteur (11) servant à produire des signaux d'excitation de micro-ondes reposant sur le calcul du premier temps de chauffage (T1) et du second temps de chauffage (T2) produit par les moyens de détection du temps de chauffage (7) et le troisième temps de chauffage (T3) produit par lesdits moyens opérationnels (10);et
des moyens d'excitation de sortie (12) servant à contrôler un approvisionnement en énergie micro-onde pour les aliments en fonction des signaux d'excitation dudit compteur (11).

2. Appareil selon la revendication 1, **caractérisé en ce que** lesdits moyens formant capteur (5) sert à mesurer une variation du paramètre prédéterminé, déterminée à partir du groupe de paramètres concernant le gaz, la température, l'humidité absolue, l'humidité relative, les rayons infra-rouges et leurs combinaisons.

3. Appareil selon la revendication 1, **caractérisé en ce que** lesdits moyens de détection du temps de chauffage (7) sélectionnent un temps d'initialisation prédéterminé (Tmin) comme premier temps de chauffage (T1), dans le cas où la valeur minimale (dG1) du ratio variable n'est pas atteinte, et produisent une valeur pour le ratio variable (Rs/Ro) au temps donné (Tmin) comme premier temps de chauffage (T1).

4. Appareil selon la revendication 1, **caractérisé en ce que** ledit second temps de chauffage (T2) représente le temps durant lequel le ratio variable (Rs/Ro) atteint, à partir de la fin du premier temps de chauffage (T1), une valeur prédéterminée (dG).

5. Appareil selon la revendication 1, **caractérisé en ce que** lesdits moyens opérationnels (10) comprennent un niveau de chauffage sélectionné par l'utilisateur et lesdits moyens opérationnels (10) produisent ledit troisième temps de chauffage (T3) contrôlé en fonction du niveau de chauffage en multipliant le temps de chauffage total (Tt) par un coefficient prédéterminé (β) défini par le niveau de chauffage et en additionnant la valeur multipliée (δT) au troisième temps de chauffage (T3) ou en la soustrayant de celui-ci.

6. Appareil selon la revendication 1, **caractérisé en ce que** la valeur prédéterminée (dG) est obtenue en divisant ledit premier temps de chauffage (T1) par le premier coefficient (a).

7. Procédé de contrôle du temps de chauffage, comprenant les étapes suivantes :

conversion d'un paramètre physique (Rs) d'un aliment alors que l'aliment est chauffé en utilisant un ratio variable (Rs/Ro) en se basant sur une valeur initiale (Ro) dudit paramètre et calcul d'un premier temps de chauffage (T1) jusqu'à ce que le ratio variable converti(Rs/Ro) devienne une valeur minimale (dG1) ;
calcul d'une valeur divisée prédéterminée (dG) en divisant le premier temps de chauffage (T1) par le premier coefficient (a) en fonction du type d'aliment à chauffer et calcul d'un second temps de chauffage (T2) jusqu'à ce que le ratio variable (Rs/Ro) passe de la valeur minimale (dG1) à ladite valeur divisée (dG) ;
calcul d'un troisième temps de chauffage (T3) en multipliant un second coefficient correspondant à un type d'aliments (K) par la somme dudit premier temps de chauffage (T1) et dudit second temps de chauffage (T2) ; et
fin de l'ensemble du processus de chauffage,

une fois ledit troisième temps de chauffage (T3) calculé écoulé.

8. procédé selon la revendication 7, **caractérisé en ce que** ladite étape consistant à déterminer ledit premier temps de chauffage (T1) comprend la sélection comme premier temps de chauffage susmentionné (Tmin) d'un temps d'initialisation prédéterminé lorsque ledit ratio variable (Rs/Ro) augmente et génère comme valeur minimale la valeur (dG1) du ratio variable (Rs/Ro) durant le temps sélectionné (Tmin).

9. Procédé selon la revendication 7, intégrant l'obtention dudit troisième temps de chauffage (T3) en fonction du niveau de chauffage prédéterminé en additionnant la valeur (δT) obtenue en multipliant un temps de chauffage total calculé (dT) par un coefficient prédéterminé (β) au troisième temps de chauffage ou en la soustrayant de celui-ci, juste après la mise en fonction du troisième temps de chauffage (T3), au cas où un utilisateur contrôlerait un niveau de chauffage.

FIG. 1

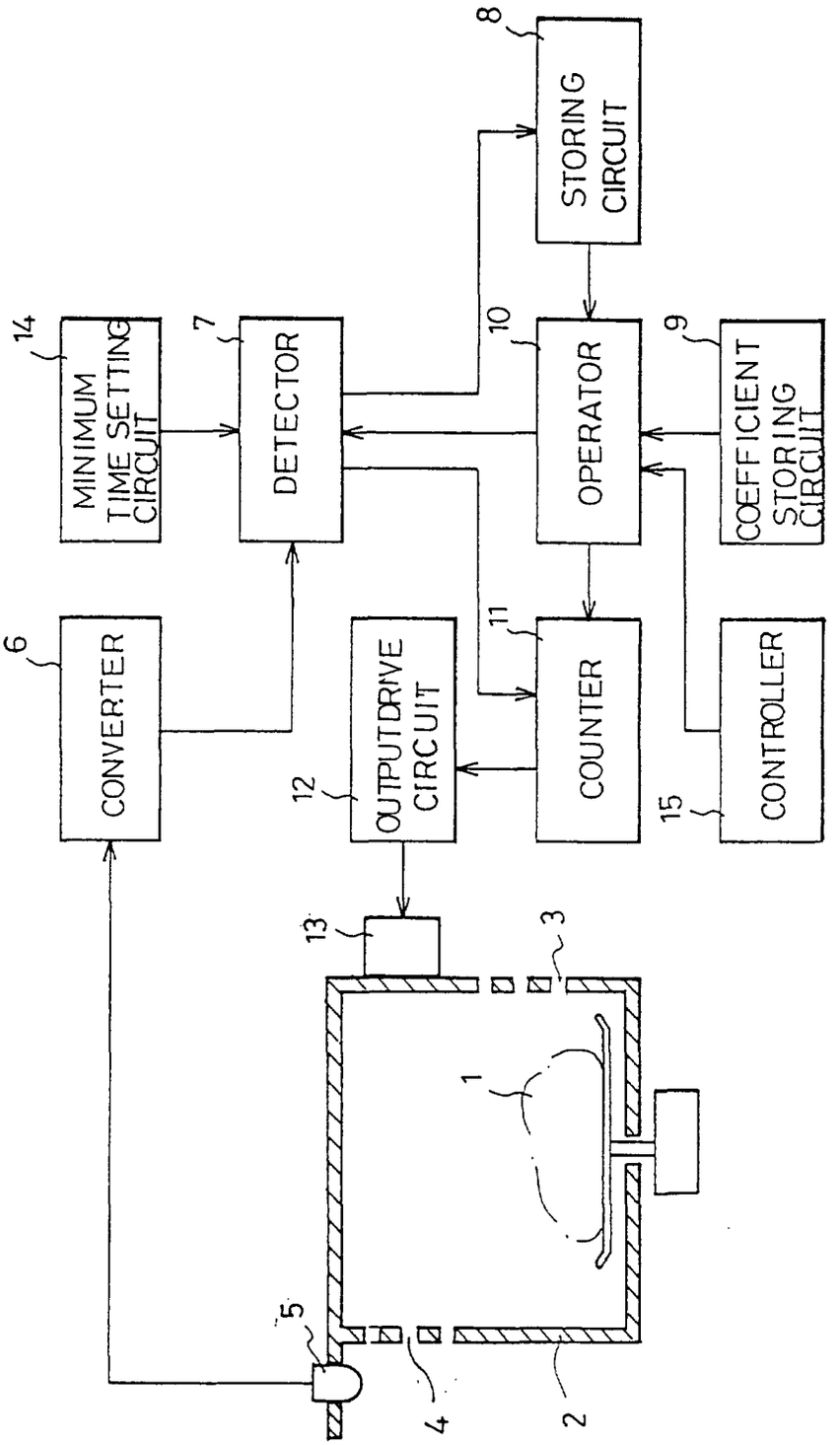

8
STORING CIRCUIT
14
MINIMUM TIME SETTING CIRCUIT
7
DETECTOR
10
OPERATOR
9
COEFFICIENT STORING CIRCUIT
6
CONVERTER
11
12
OUTPUT DRIVE CIRCUIT
COUNTER
15
CONTROLLER
13
3
1
5
4
2

FIG. 2

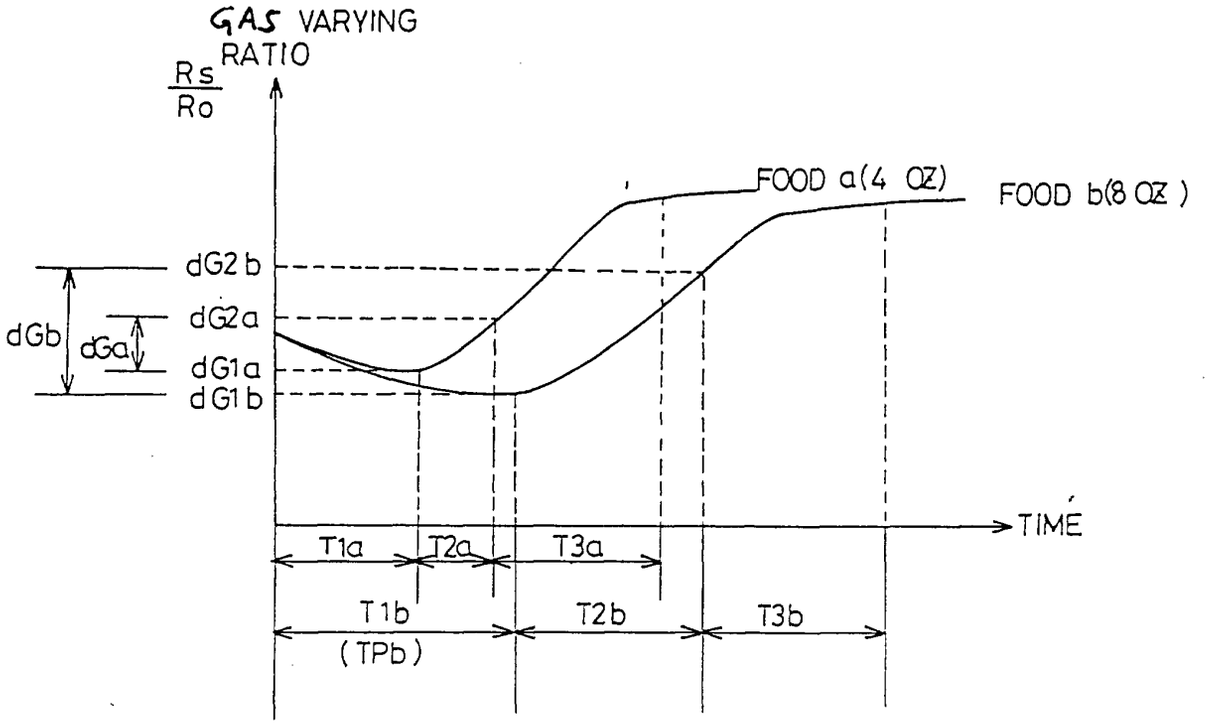

GAS VARYING RATIO
Rs/Ro
FOOD a(4 OZ)
FOOD b(8 OZ)
dG2b
dG2a
dGb
dGa
dG1a
dG1b
TIME
T1a
T2a
T3a
T1b
(TPb)
T2b
T3b

FIG. 3

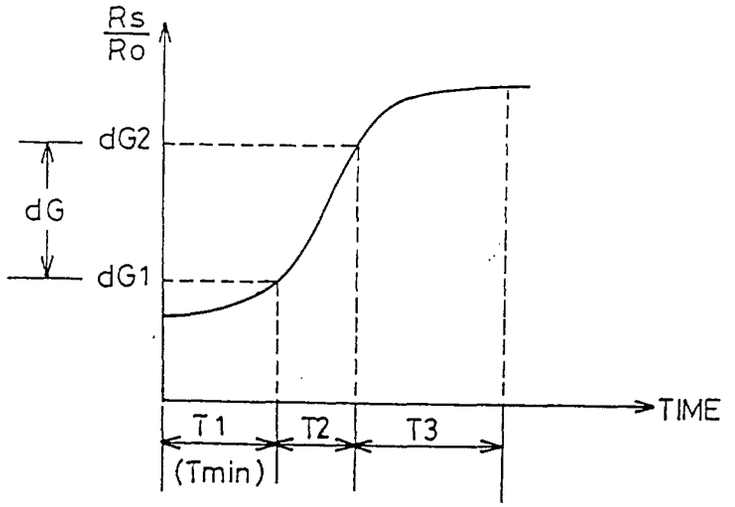

Rs/Ro
dG2
dG
dG1
TIME
T1
(Tmin)
T2
T3

FIG.4

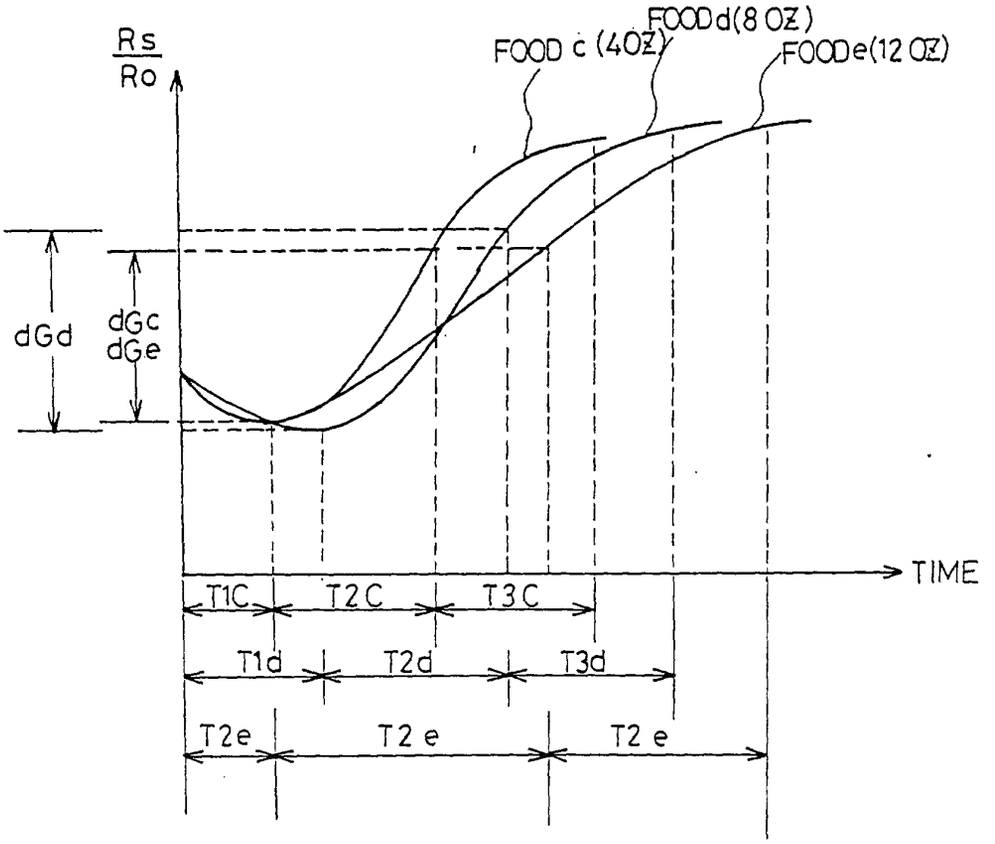

Rs
Ro
FOOD c (40Z)
FOOD d(8 OZ)
FOOD e(12 OZ)
dGd
dGc
dGe
TIME
T1C
T2C
T3C
T1d
T2d
T3d
T2e
T2 e
T2 e

FIG.5

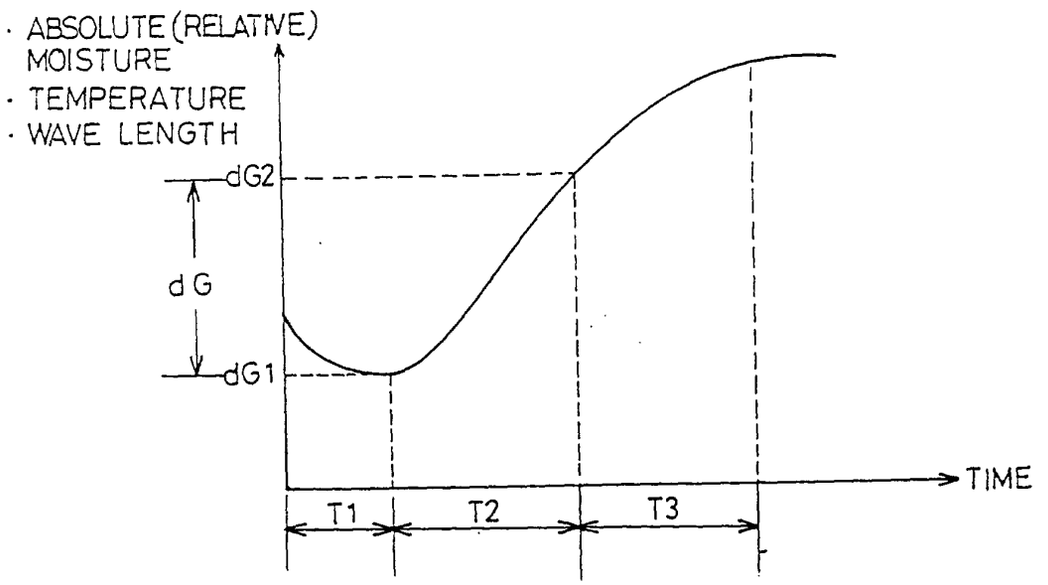
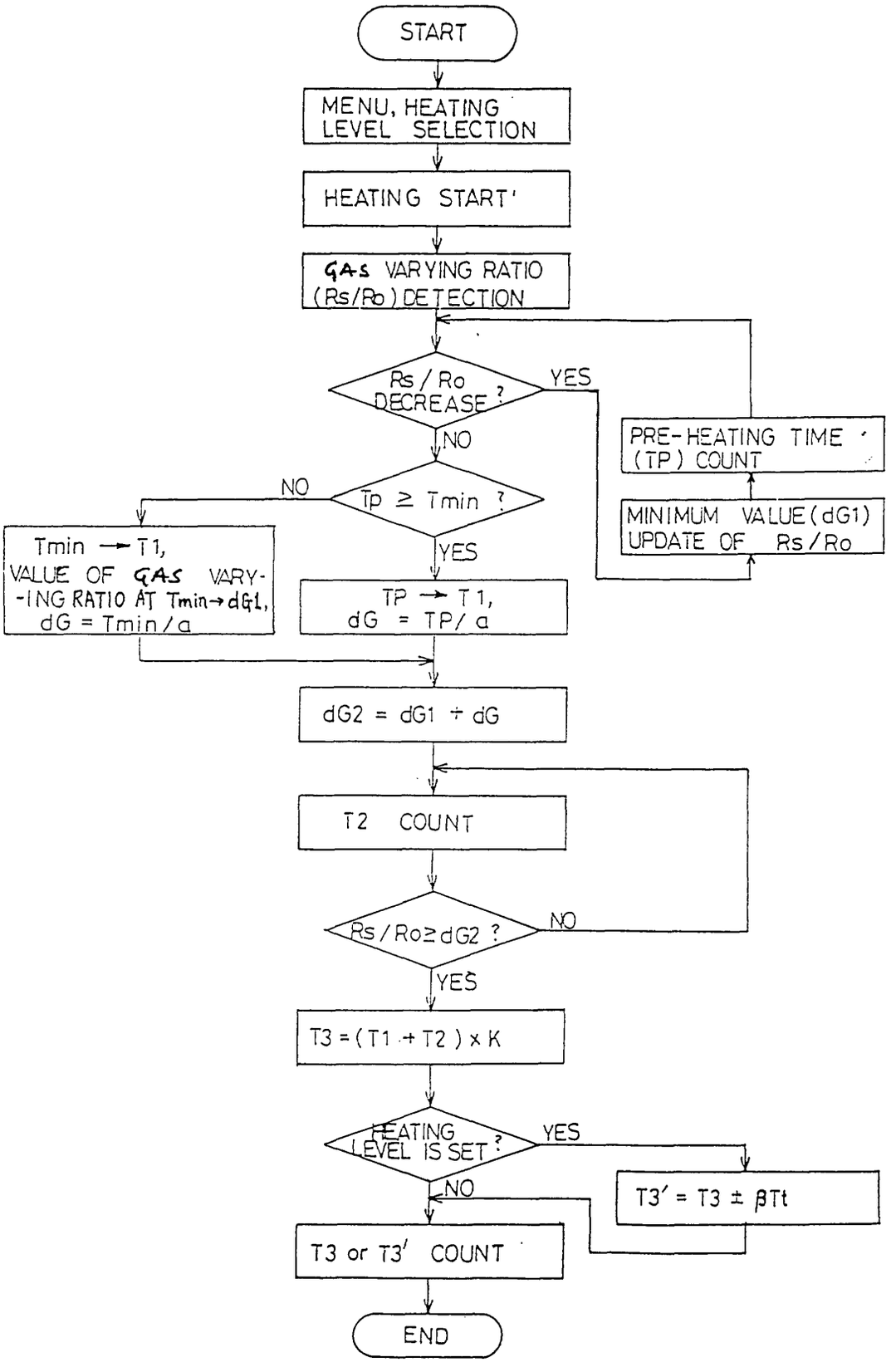

· ABSOLUTE (RELATIVE) MOISTURE
· TEMPERATURE
· WAVE LENGTH
dG2
dG
dG1
TIME
T1
T2
T3

FIG. 6


START
MENU, HEATING LEVEL SELECTION
HEATING START
GAS VARYING RATIO (Rs/Ro) DETECTION
Rs / Ro DECREASE ?
YES
NO
PRE-HEATING TIME (TP) COUNT
MINIMUM VALUE (dG1) UPDATE OF Rs/Ro
NO
Tp ≥ Tmin ?
YES
Tmin → T1, VALUE OF GAS VARYING RATIO AT Tmin → dG1, dG = Tmin / a
TP → T1, dG = TP / a
dG2 = dG1 + dG
T2 COUNT
Rs / Ro ≥ dG2 ?
NO
YES
T3 = (T1 + T2) × K
HEATING LEVEL IS SET ?
YES
NO
T3′ = T3 ± βTt
T3 or T3′ COUNT
END